

CHAPTER 1

GENERAL SPECIFICATIONS FOR ELECTRICAL EQUIPMENT

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SECTION 1 - GLOSSARY

1.1 Wherever the following terms or abbreviations are used, the intent and meaning shall be interpreted as follows:

A	- Ampere
AC	- Alternating Current
AC+	- 120 Volts AC, 60 hertz ungrounded power source
AC-	- 120 Volts AC, 60 hertz grounded return to the power source
ACIA	- Asynchronous Communications Interface Adapter Device
ANSI	- American National Standard Institute
ASCII	- American Standard Code for Information Interchange
Assembly	- A complete machine, structure or unit of a machine that was manufactured by fitting together parts and/or modules
ASTM	- American Society for Testing and Materials
(*)	
AWG	- American Wire Gage
C	- Celsius
C Language	- The ANSI C Programming Language
Cabinet	- An outdoor enclosure generally housing the controller unit and associated equipment
Certificate of Compliance	- A certificate signed by the manufacturer of the material or the manufacturer of assembled materials stating that the materials involved comply in all respects with the requirements of the specifications
Channel	- An information path from a discrete input to a discrete output
CIA	- CMS Controller Isolation Assembly
CIP	- CMS Interface Panel

CMOS	-	Complementary Metal Oxide Semiconductor
CMS	-	Changeable Message Sign
CMS SYSTEM	-	Includes Controller Unit, Model 334C Cabinet, Interconnect Harnesses, CMS and other associated equipment required to operate the system.
Component	-	Any electrical or electronic device
Contractor	-	The person or persons, manufacturer, firm, partnership, corporation, vendor or combination thereof, who have entered into a contract with the STATE, as party (s) of the second part or legal representative
Controller Unit	-	That portion of the controller assembly devoted to the operational control of the logic decisions programmed into the assembly
CPDA	-	CMS Pixel Driver Assembly
CPDM	-	CMS Pixel Driver Module
CPMM	-	CMS Pixel Matrix Module
CPU	-	Central Processing Unit
CR	-	ACIA Control Register
CRC	-	Cyclic Redundancy Check
DAT Program	-	The STATE Department of Transportation's Diagnostic and Acceptance Test Program
dB	-	Decibel
dBa	-	Decibels above reference noise, adjusted
DC	-	Direct Current
DIN	-	Deutsche Industrie Norm
DMA	-	Direct Memory Access
DTA	-	Down Time Accumulator
EG	-	Equipment Ground

EIA	- Electronic Industries Association
EMI	- Electro-Magnetic Interference
Engineer	- The director of the STATE Department of Transportation, acting either directly or through properly authorized agents, such agents acting within the scope of the particular duties delegated to them
EPROM	- Ultraviolet Erasable, Programmable, Read Only Memory Device
EEPROM	- Electrically Erasable, Programmable, Read Only Memory Device
Equal	- Connectors: comply to physical dimensions, contact material, plating and method of connection. Devices: comply to function, pin out, electrical and operating parameter requirements, access times and interface parameters of the specified device
ETL	- Electrical Testing Laboratories, Inc.
Firmware	- A computer program or software stored permanently in PROM, EPROM, ROM or semi-permanently in EEPROM
FLASH	- A +5 VDC powered IC Memory Device with nonvolatile, electrically erasable, programmable, 100K read/write minimum cycles and fast access time features
FPA	- Front Panel Assembly
HEX	- Hexadecimal
Hz	- Hertz
IC	- Integrated Circuit
I.D.	- Identification
IEEE	- Institute of Electrical and Electronics Engineers
ISO	- International Standards Organization
Jumper	- A means of connecting/disconnecting two or more conductive by soldering/desoldering a conductive wire or by PCB post jumper
KB	- Kilobytes
Laboratory	- The established laboratory of the STATE or other laboratories authorized by the STATE to test materials involved in the contract

LED	-	Light Emitting Diode
LOGIC	-	Negative Logic Convention (Ground True) State
LSB	-	Least Significant Byte
lsb	-	Least Significant Bit
MB (*)	-	Megabyte
MSB	-	Most Significant Byte
msb	-	Most Significant Bit
m	-	Milli
MCU/MPU/ IMP	-	Micro Controller Unit, Microprocessor Unit, or Integrated Multiprotocol Processor
MIL	-	Military Specifications
MODEM	-	Modulation/Demodulation Unit
Module	-	A functional unit that plugs into an assembly
Motherboard	-	A printed circuit connector interface board with no active or passive components
MOS	-	Metal-Oxide Semiconductor
MOV	-	Metal-Oxide Varistor
MS	-	Military Standards
M/170	-	Program Module/Model 170 Controller Unit Connector
M/170E	-	Model 170E Auxiliary Board Connector
N	-	Newton: SI unit of force
N.C.	-	Normally closed contact
N.O.	-	Normally open contact
NA	-	Presently Not Assigned. Cannot be used by the contractor for other purposes

NEMA	-	National Electrical Manufacturer's Association
NETA	-	National Electrical Testing Association, Inc.
n	-	nano
NLSB	-	Next Least Significant Byte
nlsb	-	Next Least Significant Bit
NMSB	-	Next Most Significant Byte
nmsb	-	Next Most Significant Bit
PCB	-	Printed Circuit Board
PDA	-	Power Distribution Assembly
PLA/PAL	-	Programmable Array Logic Device
Power Failure	-	A Power Failure is said to have occurred when the incoming line voltage falls below 92 +/- 2 VAC for 50 ms. See Power Conditions.
Power Restoration	-	Power is said to be restored when the incoming line voltage equals or exceeds 97 +/- 2 VAC for 50 ms. See Power Conditions.
Power Conditions	-	16.7 ms (one 60 Hz cycle) reaction period is allowed to be included in the 50 ms timing or added to (67 ms duration). The hysteresis between power failure and power restoration voltage settings shall be a minimum of 5 VAC with a threshold drift of no more than 0.2 VAC.
ppm	-	Parts per million
PWM	-	Pulse Width Modulation
RAM	-	Random Access Memory
RDR	-	ACIA Receiver Data Register
RF	-	Radio Frequency
RMS	-	Root-Mean-Square
ROM	-	Read Only Memory Device

RTC	-	Model 170E Controller Unit Real Time Clock. This circuitry provides a 170E CPU IRQ Interrupt pulse clocked off of the local power company's line frequency every 16.67 ms.
RTCA	-	Real Time Clock Adjuster Circuitry
RTS	-	Request to Send
R/W	-	Model 170E Controller Unit Read/Write Control Line
SCI	-	Serial Communications Interface
SDLC	-	Synchronous Data Link Control
S	-	Logic State
s	-	second
Second Sourced	-	Produced by more than one manufacturer
SR	-	ACIA Status Register
SRAM	-	Static Random Access Memory Device
STATE	-	State of California or other government purchasing agency
SW	-	Switch
TB	-	Terminal Block
TDR	-	ACIA Transmit Data Register
TOD	-	Time Of Day Clock
Triac	-	Silicon-Controlled Rectifier which controls power bilaterally in an AC switching circuit
TTL	-	Transistor-Transistor Logic
Thumb Screw Device	-	(TSD) A retractable screw fastener with projecting stainless steel screw, spring and natural aluminum knob finish. (TSD No. 2 shall be flat black.) TSD No. 1 - 8-32 SOUTHCO #47-62-301-20 or equal. TSD No. 2 - 8-32 SOUTHCO #47-62-301-60 or equal. TSD No. 3 - M3 SOUTHCO #47-82-101-10 or equal.

u	- Micro
UL	- Underwriter's Laboratories, Inc.
VAC	- Voltage Alternating Current
VDC	- Voltage Direct Current
VMA	- Valid Memory Address
VME	- Versa Module Eurocard, VMEbus Standard IEEE P1014/D1.2
x	- Number Value
XX	- Manufacturer's Option
WDT	- Watchdog Timer: A monitoring circuit, external to the device watched, which senses an Output Line from the device and reacts

SECTION 2 - GENERAL

1.2.1 (*) In CASE of CONFLICT, the individual chapter shall govern over Chapter 1.

1.2.2 (*) All furnished equipment shall be new and unused. Vacuum or gaseous tubes and electro-mechanical devices (unless specifically called out) shall not be used.

1.2.3 (*) INTERCHANGEABILITY - The following assemblies and their respective associated devices shall electrically and mechanically intermate and be compatible with each other:

ASSEMBLIES	ASSOCIATED DEVICES
Output File #1 & #2	<ul style="list-style-type: none">- Model 200 Switch Pack- Model 210 Monitor Unit- Model 430 Heavy Duty Relay
Input File	<ul style="list-style-type: none">- Models 222, 224, & 232E Detectors- Models 242 & 252 Isolators
PDA #2	<ul style="list-style-type: none">- Model 204 Flasher Unit- Model 206 Power Supply Module
PDA #3	<ul style="list-style-type: none">- Model 200 Switch Pack- Model 206 Power Supply Module- Model 208 Monitor Unit- Model 430 Heavy Duty Relay
PDA #4	<ul style="list-style-type: none">- Model 206 Power Supply- CMS Isolation Module
Model 170E Controller Unit	<ul style="list-style-type: none">- Cabinet Models 332, 334 & 336- Model 400 MODEM- Model 412C Program Module- Model 172 Computer Module
Model 2070 Controller Unit	<ul style="list-style-type: none">- Cabinet Models 332, 334,, 336 & ITS- Model 2070-1 CPU Module- Model 2070-2A & 2B Field I/O Module- Model 2070-3 Front Panel Assembly- Model 2070-4 Power Supply- Model 2070-5 VME Cage Assembly- Model 2070-6 Serial Comm Module- Model 2070-7 Serial Comm Module

Model 2070N Controller Unit	<ul style="list-style-type: none"> - Model 2070 Controller Unit - Model 2070-8 NEMA Module - Model 2070-2B Field I/O Module
Pixel Driver Assembly	<ul style="list-style-type: none"> - Pixel Driver Module

1.2.4 DOCUMENTATION

1.2.4.1 Two copies of Manual Documentation shall be supplied for each item purchased up to 200 manuals per order. The manual shall be bound in durable covers made of either 65-pound stock paper or clear plastic. The manual shall be printed on 215.9 mm by 279.4 mm paper, with the exception that schematics, layouts, parts lists and plan details may be on 279.4 mm by 431.8 mm sheets, with each sheet neatly folded to 215.9 mm by 279.4 mm size. Manual text font shall be HELVETICA BOLD. Text characters shall be no more than 10 characters per 25.4 mm and 7 lines per 25.4 mm, with the exception of schematic text, which shall be no more than 18 characters per 25.4 mm and 11 lines per 25.4 mm.

1.2.4.2 Each manual shall include the following parts in the order listed:

- 1. Table of Contents**
- 2. Glossary**
- 3. General Description**
- 4. General Characteristics**
- 5. Installation**
- 6. Adjustments**
- 7. Theory of Operation**
 - a. Systems Description (include block diagram).**
 - b. Detailed Description of Circuit Operation.**
- 8. Maintenance**
 - a. Preventive Maintenance.**
 - b. Trouble Analysis.**
 - c. Trouble Shooting Sequence Chart.**
 - d. Wave Forms.**
 - e. Voltage Measurements.**
 - f. Alignment Procedures.**

9. **Parts List (include circuit and board designation, part type and class, power rating, component manufacturer, mechanical part manufacturer, data specification sheets for special design components and original manufacturer's part number).**
10. **Electrical Interconnection Details & Drawings.**
11. **Schematic and Logic Diagram**
12. **Assembly Drawings and a pictorial diagram showing physical locations and identification of each component or part.**
13. **The date, serial numbers and revision numbers of equipment covered by the manuals shall be printed on the front cover of the manuals.**

1.2.4.3 (*) Manuals for the cabinet shall be furnished in the cabinet plastic pouch.

1.2.4.4 A preliminary draft of the manual shall be submitted to the Engineer for approval prior to final printing.

1.2.5 PACKAGING - Each item delivered shall be individually packed in its own shipping container. When loose Styrofoam is used for packing the item, the item shall be sealed in a plastic bag to prevent direct contact with the Styrofoam.

1.2.6 DELIVERY - Each item delivered for testing shall be complete, including manuals, and ready for testing.

1.2.7 METALS

1.2.7.1 ALUMINUM - Sheet shall be 3.175 mm (0.125-inch) minimum thick Type 3003-H14 or Type 5052-H32 ASTM Designation B209 aluminum alloy. Rod, Bar and Extruded shall be Type 6061-T6, or equal.

1.2.7.2 STAINLESS STEEL - Sheet shall be annealed or one-quarter-hard complying with the ASTM Designation: A666 for Type 304, Grades A or B, stainless steel sheet.

1.2.7.3 COLD ROLLED STEEL - Sheet, Rod, Bar and Extruded shall be Type 1018/1020.

1.2.7.3.1 Plating - All cold roll steel shall be plated. All plating shall be either cadmium plating meeting the requirements of Federal Specification QQ-P-416C, Type 2 Class I or zinc plating meeting the requirements of ASTM B633-85 Type II SC4.

1.2.7.4 All sharp edges and corners shall be rounded.

1.2.8 (*) All bolts, nuts, washers, screws (size 8 or larger), hinges and hinge pins shall be stainless steel unless otherwise specified.

1.2.9 (*) Within the circuit of any device, module, or PCB, electrical isolation shall be provided between DC logic ground, equipment ground and the AC grounded conductor. They shall be electrically isolated from each other by 500 megohms, minimum, when tested at the input terminals with 500 VDC.

SECTION 3 - COMPONENTS

1.3.1 GENERAL - All components shall be second sourced and shall be of such design, fabrication, nomenclature or other identification as to be purchased from a wholesale distributor or from the component manufacturer, except as follows:

1.3.1.1 When a component is of such special design that it precludes the purchase of identical components from any wholesale distributor or component manufacturer, one spare duplicate component shall be furnished with each 20, or fraction thereof, components used.

1.3.1.2 The electronic circuit design shall be such that all components of the same generic type, regardless of manufacturer, shall function equally in accordance with the specifications.

1.3.2 ELECTRONIC COMPONENTS

1.3.2.1 (*) No device shall be socket mounted unless specifically called out.

1.3.2.2 No component shall be operated above 80% of its maximum rated voltage, current or power ratings. Digital components shall not be operated above 3% over their nominal voltage, current, or power ratings.

1.3.2.3 No component shall be provided where the manufactured date is 2 years older than the contract award date. The design life of all components, operating for 24 hours a day and operating in their circuit application, shall be 10 years or longer.

1.3.2.4 (*) Encapsulation of 2 or more discrete components into circuit modules is prohibited, except for transient suppression circuits, resistor networks, diode arrays, solid- state switches, optical isolators and transistor arrays.. Components shall be arranged so they are easily accessible, replaceable and identifiable for testing and maintenance. Where damage by shock or vibration exists, the component shall be supported mechanically by a clamp, fastener, retainer, or hold-down bracket.

1.3.2.5 The Contractor shall submit detailed engineering technical data on all components at the request of the Engineer. A letter from the component manufacturer shall be submitted with the detailed engineering data when the proposed application of the component alters the technical data. The letter shall certify that the component application meets specification requirements.

1.3.3 CAPACITORS - The DC and AC voltage ratings as well as the dissipation factor of a capacitor shall exceed the worst-case design parameters of the circuitry by 150%. Capacitor encasements shall be resistant to cracking, peeling, and discoloration. All capacitors shall be insulated and shall be marked with their capacitance values and working voltages. Electrolytic capacitors shall not be used for capacitance values of less than 1.0 microfarad and shall be marked with polarity.

1.3.4 (*) POTENTIOMETERS - Potentiometers with ratings from 1 to 2 watts shall meet Military Type RV4 requirements. Under 1 watt potentiometers shall be used only for trimmer-type function. The potentiometer power rating shall be at least 100% greater than the maximum power requirements of the circuit.

1.3.5 RESISTORS - Fixed carbon film, deposited carbon, or composition insulated resistors shall conform to the performance requirements of Military Specifications MIL-R-11F or MIL-R-22684. All resistors shall be insulated and shall be marked with their resistance values. Resistance values shall be indicated by the EIA color codes or stamped value. The value of the resistors shall not vary by more than 5% between -37 degrees C and 74 degrees C.

1.3.5.1 (*) Special ventilation or heat sinking shall be provided for all 2-watt or greater resistors. They shall be insulated from the PCB.

1.3.6 SEMICONDUCTOR DEVICES

1.3.6.1 All solid-state devices, except LED's, shall be of the silicon type.

1.3.6.2 All transistors, integrated circuits, and diodes shall be a standard type listed by EIA and clearly identifiable.

1.3.6.3 All metal oxide semiconductor components shall contain circuitry to protect their inputs and outputs against damage due to high static voltages or electrical fields.

1.3.6.4 (*) Device pin “1” locations shall be properly marked on the PCB adjacent to the pin.

1.3.7 (*) TRANSFORMERS AND INDUCTORS - All power transformers and inductors shall have the manufacturer's name or logo and part number clearly and legibly printed on the case or lamination. All transformers and inductors shall have their windings insulated, shall be protected to exclude moisture, and their leads color coded with an approved EIA color code or identified in a manner to facilitate proper installation.

1.3.8 (*) TRIACS - Each triac with a designed circuit load of greater than 0.5 Amperes at 120 VAC shall be mounted to a heat sink with a machine screw and nut with integral lockwasher.

1.3.9 (*) CIRCUIT BREAKERS shall be listed by UL or ETL. The trip and frame sizes shall be plainly marked (marked on the breaker by the manufacturer), and the ampere rating shall be visible from the front of the breaker. Contacts shall be silver alloy and enclosed in an arc quenching chamber. Overload tripping shall not be influenced by an ambient air temperature range of from -18 degrees C to 50 degrees C. The minimum Interrupting Capacity shall be 5,000 Amperes, RMS when the breaker is secondary to a UL approved fuse or primary circuit breaker and both breakers in concert provide the rated capacity. For circuit breakers 80 amperes and above, the minimum interrupting capacity shall be 10,000 amperes, RMS. Circuit breakers shall be the trip-free type with medium trip delay characteristic (Carlingswitch Time Delay Curve #24 or equal).

1.3.10 (*) All FUSES shall be 3AG Slow Blow type and resident in a holder. Fuse size rating shall be labeled on the holder. Fuses shall be easily accessible and removable without use of tools.

1.3.11 SWITCHES

1.3.11.1 DIP - Dual-inline-package, quick snap switches shall be rated for a minimum of 30,000 operations per position at 50 mA, 30 VDC. The switch contact resistance shall be 100 milliohms maximum at 2 mA, 30 VDC. The contacts shall be gold over brass (or silver). Contact for VAC or 28 VDC and shall be silver over brass (or equal).

1.3.11.2 LOGIC - The switch contacts shall be rated for a minimum of one ampere resistive load at 120 VAC and shall be silver over brass (or equal). The switch shall be rated for a minimum of 40,000 operations.

1.3.11.3 CONTROL - The switch contacts shall be rated for a minimum of five ampere resistive load at 120 VAC or 28 VDC and shall be gold over brass (or equal). The switch shall be rated for a minimum of 40,000 operations.

1.3.11.4 POWER - Ratings shall be the same as CONTROL, except the contact rating shall be a minimum of ten amperes at 125 VAC.

1.3.12 (*) TERMINAL BLOCKS - The terminal blocks shall be barrier type, rated at 20 amperes and 600 VAC RMS minimum. The terminal screws shall be 7.938 mm minimum length nickel plated brass binder head type with screw inserts of the same material. Screw size is called out under the associated file, panel, or assembly.

1.3.13 WIRING, CABLING, AND HARNESES

1.3.13.1 (*) HARNESES shall be neat, firm and properly bundled with external protection. They shall be tie-wrapped and routed to minimize crosstalk and electrical interference. Each harness shall be of adequate length to allow any conductor to be connected properly to its associated connector or termination point. Conductors within an encased harness have no color requirements.

1.3.13.2 Wiring containing AC shall be bundled separately or shielded separately from all DC logic voltage control circuits.

1.3.13.3 Wiring shall be routed to prevent conductors from being in contact with metal edges. Wiring shall be arranged so that any removable assembly may be removed without disturbing conductors not associated with that assembly.

1.3.13.4 All conductors shall conform to MIL-W-16878E/1 or better and shall have a minimum of 19 strands of copper. The insulation shall be polyvinyl chloride with a minimum thickness of 10 mils or greater. Where insulation thickness is 15 mils or less, the conductor shall conform to MIL-W-16878/17.

1.3.13.5 (*) Conductor color identification shall be as follows:

Grounded AC circuits - gray or white

Equip. Ground - solid green or continuous green color with 1 or more yellow stripes.

DC logic ground - continuous white with a red stripe.

Ungrounded AC+ - continuous black or black with colored stripe.

DC logic ungrounded or signal - any color not specified

1.3.14 INDICATORS AND CHARACTER DISPLAYS - All indicators and character displays shall be readily visible at a radius of up to 1.2 m (4 feet) within the cone of visibility when the indicator is subjected to 97,000 lux (9,000 foot-candles) of white light with the light source at 45 ± 2 degrees to the front panel.

1.3.14.1 (*) INDICATORS - All indicators and character displays shall have a minimum 90 degrees cone of visibility with its axis perpendicular to the panel on which the indicator is mounted. All indicators shall be self-luminous. All indicators shall have a rated life of 100,000 hours minimum. Each LED indicator shall be white or clear when off and red when on. Indicators supplied on equipment requiring handles shall be mounted such that a horizontal clearance of 15 degrees minimum shall be provided for Models 208, 210, 212, 222, 232, 242, and 252, as well as a clearance of 30 degrees minimum for Models 200, 204, and 206.

1.3.14.2 CHARACTER DISPLAYS - Liquid Crystal Displays (LCD) shall operate at temperatures of -20 degrees C to +70 degrees C.

1.3.15 CONNECTORS -

1.3.15.1 GENERAL - All connectors shall be keyed to prevent improper insertion of the wrong connector. The mating connectors shall be designated as the connector number and male/female relationship, such as C1P (plug or PCB edge connector) and C1S (socket).

1.3.15.2 The TYPE T connector shall be a single row, 10 position feed through terminal block. The terminal block shall be a barrier type with 6-32, 6.35 mm, or longer nickel plated brass binder head screws. Each terminal shall be permanently identified as to its function.

1.3.15.3 (*) PLASTIC CIRCULAR and M TYPE CONNECTORS - Pin and socket contacts for connectors shall be beryllium copper construction subplated with 0.00127 mm nickel and plated with 0.00076 mm gold. Pin diameter shall be 1.57 mm. All pin and socket connectors shall use the AMP #601105-1 or #91002-1 contact insertion tool and the AMP #305183 contact extraction tool.

1.3.15.4 CARD EDGE and TWO-PIECE PCB CONNECTORS

1.3.15.4.1 PCB edge connectors shall have bifurcated gold-plated contacts. The PCB receptacle connector shall meet or exceed the following:

Operating Voltage:	600 VAC (RMS)
Current Rating:	5.0 amperes
Insulation Material:	Diallyl Phthalate or Thermoplastic
Insulation Resistance:	5,000 megohms
Contact Material:	Copper alloy plated with 0.00127 mm (0.00005 inch) of nickel and 0.000381 mm (0.000015 inch) of gold
Contact Resistance:	0.006 ohm maximum

1.3.15.4.2 The two-piece PCB connector shall meet or exceed the DIN 41612.

1.3.15.4.3 The PCB 22/44 Connector shall have 22 independent contacts per side, dual sided with 3.96 mm (0.156 inch) contact centers.

1.3.15.4.4 The PCB 28/56 Connector shall have 28 independent contacts per side, dual sided with 3.96 mm (0.156 inch) contact centers.

1.3.15.4.5 The PCB 36/72 Connector shall have 36 independent contacts per side, dual sided with 2.54 mm (0.100 inch) contact centers.

1.3.15.4.6 The PCB 43/86 Connector shall have 43 independent contacts per side, dual sided with 2.54 mm (0.100 inch) contact centers.

1.3.15.5 (*) WIRE TERMINAL CONNECTORS - Each wire terminal shall be solderless with PVC insulation and a heavy duty short-locking spade type connector. All terminal connectors shall be crimped using a Controlled-Cycle type crimping tool.

1.3.15.6 FLAT CABLE CONNECTORS - Each flat cable connector shall be designed for use with 26 AWG cable; shall have dual cantilevered phosphor bronze contacts plated with 508 nm of gold over 1270 nm of nickel; and shall have a current rating of 1 A minimum and an insulation resistance of 5 megohms minimum.

1.3.15.7 PCB HEADER POST CONNECTORS - Each PCB header post shall be 1.0 mm square by 8.7 mm high; shall be mounted on 4.0 mm centers; and shall be tempered hard brass plated with 381 nm of gold over 1.270 mm of nickel.

1.3.15.8 PCB HEADER SOCKET CONNECTORS - Each PCB header socket block shall be nylon or diallyl phthalate. Each PCB header socket contact shall be removable, but crimp-connected to its conductor. The Contractor shall list the part number of the extraction tool recommended by its manufacturer. Each PCB header socket contact shall be brass or phosphor bronze plated with 562 nm of gold over 1270 nm of nickel.

1.3.16 SURGE PROTECTION DEVICE - A three-electrode gas tube type that is capable of withstanding 15 pulses of peak current each of which will rise in 8 μ s and fall in 20 μ s to 0.5 of the peak voltage at 3-minute intervals. Peak current rating shall be 20,000 amperes. It shall have the following ratings:

IMPULSE BREAKDOWN:	Less than 1,000 volts in less than 0.1 μ s at 10 KV/ μ s.
STANDBY CURRENT:	Less than 1 mA.
STRIKING VOLTAGE:	Greater than 212 volts.

SECTION 4 - MECHANICAL

1.4.1 (*) ASSEMBLIES - All assemblies shall be modular, easily replaceable, and incorporate plug-in capability for their associated devices or PCBs. Assemblies shall be provided with 2 guides for each plug-in PCB or associated device (except relays). The guides shall extend to within 19.05 mm from the face of either the socket or connector and front edge of the assembly. If Nylon guides are used, the guides shall be securely attached to the file or assembly chassis.

1.4.2 (*) PCB DESIGN - No components, traces, brackets, or obstructions shall be within 3.175 mm of the board edge (guide edges). The manufacturer's name or logo, model number, serial number, and circuit issue or revision number shall appear and be readily visible on all PCBs. Devices to prevent PC Board from backing out of their assembly connectors shall be provided.

1.4.3 (*) MODEL NUMBERS - The manufacturer's model number, serial number, and circuit issue or revision number shall appear on the rear panel of all equipment supplied (where such panel exists). In addition to any assignment of model numbers by the manufacturer, the State model number shall be displayed on the front panel in bold type at least 6.35 mm high.

1.4.4 (*) All PCB connectors mounted on a motherboard shall be mechanically secured to the chassis or frame of the unit or assembly.

1.4.5 All screw type fasteners shall utilize locking devices or locking compounds except for finger screws, which shall be captive.

1.4.6 WORKMANSHIP - Workmanship shall conform with the requirements of this specification and be in accordance with the highest industry standards.

1.4.7 TOLERANCES - The following tolerances shall apply, except as specifically shown on the plans or in these specifications:

Sheet Metal	± 1.334 mm (0.0525 inch)
PCB	+0, - 0.254 mm (0.010 inch)
Edge Guides	± 0.381 mm (0.015 inch)

SECTION 5 - ENGINEERING

1.5.1 HUMAN ENGINEERING

1.5.1.1 (*) The equipment shall be engineered for simplicity, ease of operation and maintenance.

(*)

1.5.1.2 (*) Knobs shall be a minimum of 12.7 mm in diameter and a minimum separation of 12.7 mm edge to edge.

(*)

1.5.1.3 (*) PCBs shall slide smoothly in their guides while being inserted into or removed from the frame and shall fit snugly into the plug-in PCB connectors. PCBs shall require a force no less than 22.24 N or greater than 222.4 N for insertion or removal.

1.5.2 (*) DESIGN ENGINEERING - The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcome adverse effects due to temperature in the specified environmental range. Personnel shall be protected from all dangerous voltages.

1.5.3 GENERATED NOISE - No item, component, or subassembly shall emit a noise level exceeding the peak level of 55 dBa when measured at a distance of one meter away from its surface, except as otherwise noted. No item, component, or subassembly shall emit a noise level sufficient to interfere with processing and communication functions of the controller circuits.

SECTION 6 - PRINTED CIRCUIT BOARDS

1.6.1 DESIGN, FABRICATION, AND MOUNTING

1.6.1.1 All contacts on PCBs shall be plated with a minimum thickness of 0.000763 mm gold over a minimum thickness of 0.001905 mm nickel.

1.6.1.2 (*) PCB design shall be such that when a component is removed and replaced, no damage is done to the board, other components, conductive traces, or tracks.

1.6.1.3 Fabrication of PCBs shall be in compliance with Military Specification MIL-P-13949, except as follows:

1.6.1.3.1 (*) NEMA FR-4 glass cloth base epoxy resin copper clad laminates 1.590 mm minimum thickness shall be used. Inter-component wiring shall be by laminated copper clad track having a minimum weight of 0.556 kilogram per square meter with adequate cross section for current to be carried. All copper tracks shall be plated or soldered to provide complete coverage of all exposed copper tracks. Jumper wires to external PCB components shall be from plated-through padded holes and as short as possible.

1.6.1.3.2 In Section 3.3 of Military Specification MIL-P-13949G, Grade of Pits and Dents shall be of Grade B quality (3.5.1.3) or better. Class of permissible bow or twist shall be Class C (Table V) or better. Class of permissible warp or twist shall be Class A (Table II) or better.

1.6.1.3.3 Sections 4.2 through 6.6 of Military Specification MIL-P-13949G (inclusive) shall be omitted except as referenced in previous sections of this specification.

1.6.1.4 The mounting of parts and assemblies on the PCB shall conform to Military Specification MIL-STD-275E, except as follows:

1.6.1.4.1 (*) Semiconductor devices that dissipate more than 250 mW or cause a temperature rise of 10 degrees C or more shall be mounted with spacers, transipads, or heat sinks to prevent contact with the PCB.

1.6.1.4.2 When completed, all residual flux shall be removed from the PCB.

1.6.1.4.3 The resistance between any 2 isolated, independent conductor paths shall be at least 100 megohms when a 500 VDC potential is applied.

1.6.1.4.4 All PCBs shall be coated with a moisture resistant coating.

1.6.1.4.5 Where less than 6.35 mm lateral separation is provided between the PCB (or the components of a PCB) and any metal surface, a 0.79375 \pm 0.39624 mm thick Mylar (polyester) plastic cover shall be provided on the metal to protect the PCB.

1.6.1.5 Each PCB connector edge shall be chamfered at 30 degrees from board side planes. The key slots shall also be chamfered so that the connector keys are not extracted upon removal of board or jammed upon insertion. The key slots shall be 1.143 \pm 0.127 mm for 2.54 mm spacing and 1.40 \pm 0.127 mm for 3.96 mm spacing.

1.6.2 SOLDERING

1.6.2.1 Hand soldering shall comply with Military Specification MIL-STD-2000.

1.6.2.2 Automatic flow soldering shall be a constant speed conveyor system with the conveyor speed set at optimum to minimize solder peaks or points. Temperature shall be controlled to within \pm 8 degrees C of the optimum temperature. The soldering process shall result in the complete coverage of all copper runs, joints, and terminals with solder except that which is covered by an electroplating process. Wherever clinching is not used, a method of holding the components in the proper position for the flow process shall be provided.

1.6.2.2.3 If exposure to the temperature bath is of such a time-temperature duration, as to come within 80% of any component's maximum specified time-temperature exposure, that component shall be hand soldered to the PCB after the flow process has been completed.

1.6.3 DEFINITIONS - Definitions for the purpose of this section on PCBs shall be taken from MIL-P-55110D Section 3.3 and any current addendum.

SECTION 7 - QUALITY CONTROL

1.7.1 (*) COMPONENTS - All components shall be lot sampled to assure a consistent high conformance standard to the design specification of the equipment.

1.7.2 (*) SUBASSEMBLY, UNIT, OR MODULE - Complete electrical, environmental, and timing compliance testing shall be performed on each module, unit, printed circuit, or subassembly. Housing, chassis, and connection terminals shall be inspected for mechanical sturdiness, and harnessing to sockets shall be electrically tested for proper wiring sequence. The equipment shall be visually and physically inspected to assure proper placement, mounting, and compatibility of subassemblies.

1.7.3 PREDELIVERY REPAIR

1.7.3.1 Any defects or deficiencies found by the inspection system involving mechanical structure or wiring shall be returned through the manufacturing process or special repair process for correction.

1.7.3.2 (*) PCB flow soldering is allowed a second time if copper runs and joints are not satisfactorily coated on the first run. Under no circumstances shall a PCB be flow soldered more than twice.

1.7.3.3 (*) Hand soldering is allowed for printed circuit repair.

SECTION 8 - ELECTRICAL, ENVIRONMENTAL AND TESTING REQUIREMENTS

1.8.1 (*) GENERAL - The requirements called out in these specification dealing with equipment evaluation are a minimum guide and shall not limit the testing and inspection to insure compliance.

1.8.2 (*) CERTIFICATION - These test procedures shall be followed by the Contractor who shall certify that they have conducted inspection and testing in accordance with these specifications.

1.8.3 (*) INSPECTION - A visual and physical inspection shall include mechanical, dimensional, and assembly conformance of all parts of these specifications,

1.8.4 ENVIRONMENTAL & ELECTRICAL - All components shall properly operate within the following limits unless otherwise noted:

Applied Line Voltage: 90 to 135 VAC, note "Power Failure / Restoration" limits (*)

Frequency: 60 (+/-3.0) Hertz

Humidity: 5 to 95 percent

Ambient Temperature: -37 degrees C to +74 degrees C

Shock: Test per Specification MIL-STD-810E Method 516.4

Vibration: Test per Specification MIL-STD-810E Method 514.4, equipment class G

1.8.4.1 All circuits, unless otherwise noted, shall commence operation at or below 90 VAC as the applied voltage is raised from 50 to 90 VAC at a rate of 2 (± 0.5) volts/second.

1.8.4.2 (*) All equipment shall be unaffected by transient voltages normally experienced on commercial power lines. Where applicable, equipment purchased separately from the cabinet (which normally is resident) will be tested for compliance in a State accepted cabinet connected to the commercial power lines.

1.8.4.3 The power line surge protection shall enable the equipment being tested to withstand (nondestructive) and operate normally following the discharge of a 25 microfarad capacitor, charged to $\pm 2,000$ volts, applied directly across the incoming AC line at a rate of once every 10 seconds for a maximum of 50 occurrences per test. The unit under test will be operated at 20 degrees (± 5 degrees) C and at 120 (± 12) VAC.

1.8.4.4 The equipment shall withstand (nondestructive) and operate normally when one discharge pulse of ± 300 volts is synchronously added to its incoming AC power line and moved uniformly over the full wave across 360 degrees or stay at any point of Line Cycle once every second. Peak noise power shall be 5 kilowatts with a pulse rise time of 500 ns. The unit under test will be operated at 20 degrees (± 5 degrees) C and at 120 (± 12) VAC.

1.8.4.5 (*) The controller unit communications modules shall be tested resident in a State-accepted controller unit, which in turn is housed in the cabinet.

1.8.4.6 (*) CMS system equipment will be tested for compliance as a complete system with power from commercial power lines applied at the CMS CIP Panel and the CMS Power Surge Protector deactivated or removed.

1.8.4.7 Equipment shall comply only with the requirements of UL Bulletin of Research No. 23, "Rain Tests of Electrical Equipment."

1.8.4.8 All equipment shall continue normal operation when subjected to the following:

1.8.4.8.1 Low Temperature Test - With the item functioning at a line voltage of 90 VAC in its intended operation, the ambient temperature shall be lowered from 20 degrees C to -37 degrees C at a rate of not more than 18 degrees C per hour. The item shall be cycled at -37 degrees C for a minimum of 5 hours and then returned to 20 degrees C at the same rate. The test shall be repeated with the line voltage at 135 VAC.

1.8.4.8.2 High Temperature Test - With the item functioning at a line voltage of 90 VAC in its intended operation, the ambient temperature shall be raised from 20 degrees C to 70 degrees C at a rate of not more than 18 degrees C per hour. The item shall be cycled at 70 degrees C for 5 hours and then returned to 20 degrees C at the same rate. The test shall be repeated with the line voltage at 135 VAC.

(*)

1.8.4.8.3 (*) All equipment shall resume normal operation following a period of at least 5 hours at -37 degrees C and less than 10 percent humidity and at least 5 hours at 70 degrees C and 90 percent humidity when 90 VAC is applied to the incoming AC.

1.8.4.9 The relative humidity and ambient temperature values in the following table shall not be exceeded.

**AMBIENT TEMPERATURE VERSUS RELATIVE HUMIDITY
AT BAROMETRIC PRESSURES (29.92 In. Hg.)**

Ambient Temperature/ Dry Bulb (in degrees C)	Relative Humidity (in percent)	Ambient Temperature/ Wet Bulb (in degrees C)
-37.0 to 1.1	10	-17.2 to 42.7
1.1 to 46.0	95	42.7
48.8	70	42.7
54.4	50	42.7
60.0	38	42.7
65.4	28	42.7
71.2	21	42.7
74.0	18	42.7

1.8.4.10 All equipment shall be capable of normal operation following opening and closing of contacts in series with the applied voltage at a rate of 30 openings and closings per minute for a period of 2 minutes in duration.

1.8.5 **CONTRACTOR'S TESTING CERTIFICATION**

1.8.5.1 (*) A complete QC / final test report shall be supplied with each item. The test report shall indicate the name of the tester and shall be signed by a responsible manager.

1.8.5.2 (*) The quality control procedure and test report format shall be submitted to the Engineer for approval within 15 days following the award of the contract. The quality control procedure shall include the following:

Acceptance testing of all supplied components.

Physical and functional testing of all modules and items.

A minimum 100-hour burn-in of all equipment.

Physical and functional testing of all items.

SECTION 9

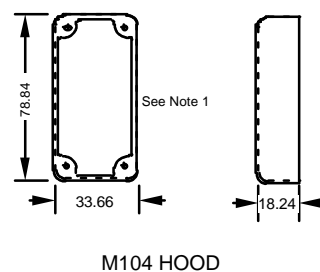
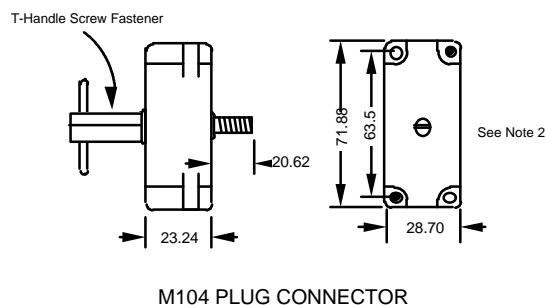
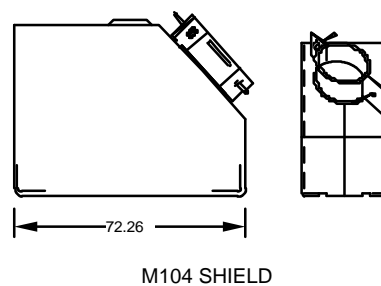
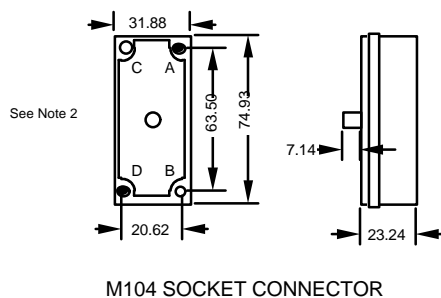
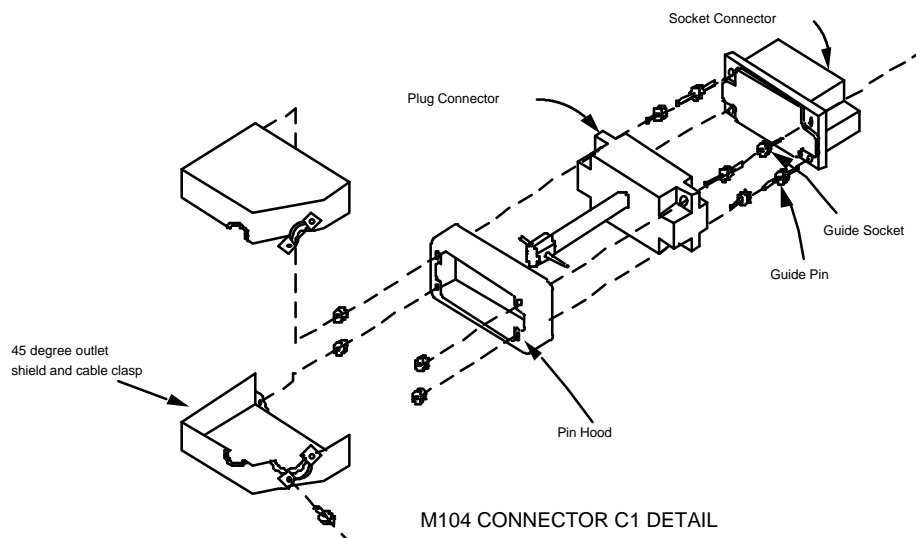
CHAPTER DETAILS

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Section Notes:

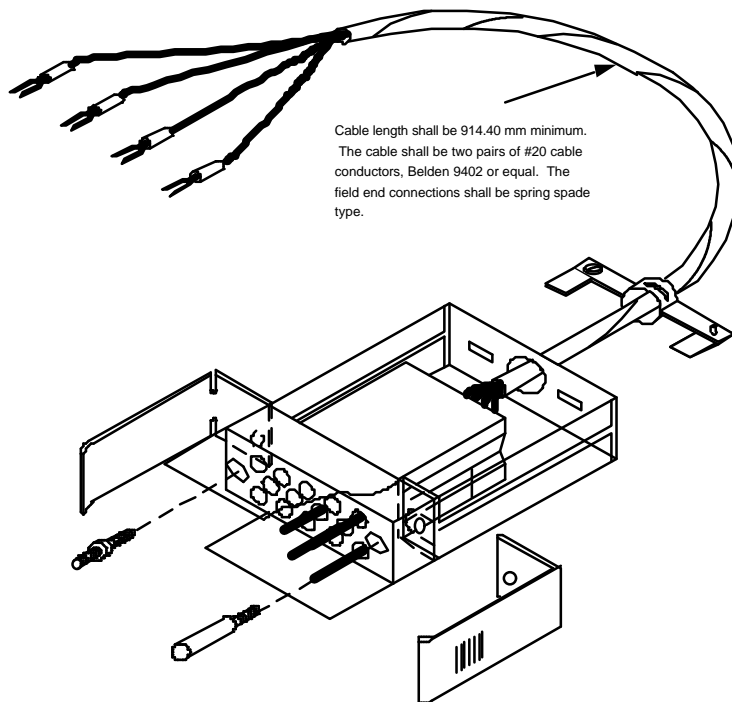
- 1. All dimensions are in millimeters.**
- 2. M Type connector blocks shall be constructed of phenolic or equal and shall have an insulation resistance of 5,000 megohms. The contacts shall be secured in the blocks with stainless steel springs.**
- 3. M Type connector corner guides shall be stainless steel. The guide pins shall be 27.86 in length and the guide sockets shall be 15.66 in length.**
- 4. Circular plastic connectors shall have quick connect/disconnect capability and thread assist positive detent coupling. The connectors shall be UL listed, glass-filled nylon, 94 V-I rated, heat stabilized and fire resistant.**



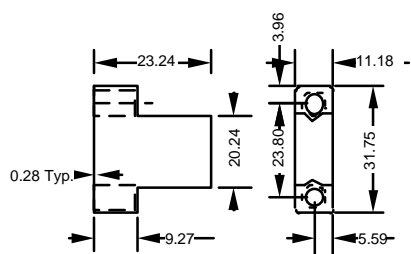
NOTES:

1. Provide clearance for M104 plug with hood when mounting to its socket.
2. The darker circles denote guide pin location and the open circles are guide sockets.

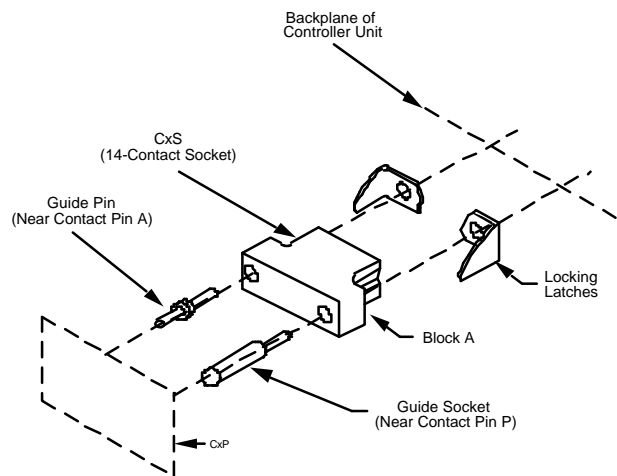
CONNECTOR DETAIL - M104



CxP MODEM INTERCONNECT HARNESS



CONNECTOR CxS

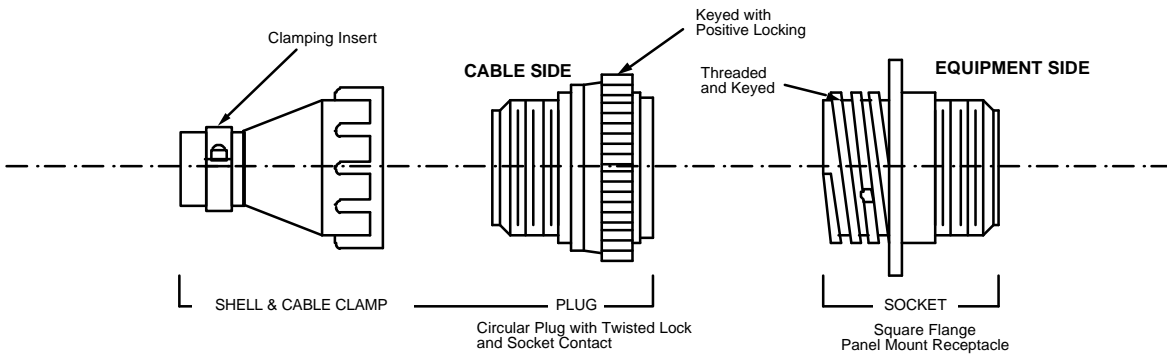


CONNECTOR Cx DETAIL

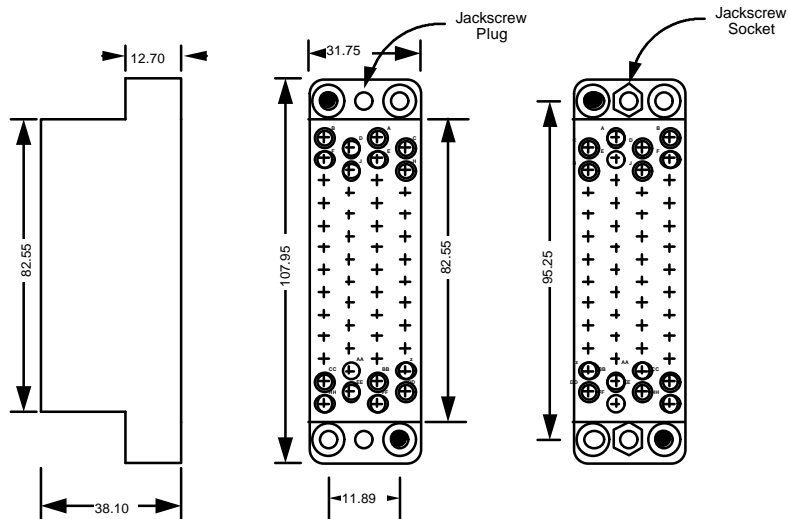
NOTE:

"x" denotes connector number.

CONNECTOR DETAIL - M14



PLASTIC CIRCULAR PLUG AND SOCKET CONNECTOR



CONNECTOR PIN ARRANGEMENT

NOTE:

Guide Pins & Sockets, and Jackscrews are centered symetrical to connector.

KEY:

- - socket
- - plug

CONNECTOR DETAIL
M50 & CIRCULAR PLASTIC CONNECTORS